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John Wren-Lewis is a member of Head Office Research and Development Department. On graduating in mathematics from Imperial College, London, in 1944, he joined a research team associated with ICI doing special wartime research and has been with the Company ever since. A rare combination of scientist and theologian, he has become well known as a writer and broadcaster.

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Peter Allen, now a deputy chairman of ICI, has been with the Company since 1928, when he joined Brunner, Mond & Co. as a chemist. Widely travelled both in his official capacity and during his holidays, he is a railway enthusiast and has written six books on the subject. He is also keen on golf, and has been interested in motor racing, about which he writes on page 174, for many years.

FRONT COVER
Graham Ashton (Dyestuffs Division Application Research and Technical Service Dept.) operates a laboratory jig when testing 'Procion' dyes in the laboratories at Blackley. *Photograph: Ronald Chapman.*

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COLOUR MATCHING BY COMPUTER
Tape and code messages of Dyestuffs' unique Instrument Match Prediction Service ►

WINNING THE QUEEN'S AWARD

Philip Reilly

In a few short months the blue and gold emblem of the Queen's Award to Industry has become widely accepted as a recognition of outstanding performance in exports or in technological advance. Just how good is outstanding, and what does it take to win the award?

Within ICI, one place to look for the answers is in Dyestuffs Division, among the first winners of the award earlier this year. Also on the list were Agricultural Division, Pharmaceuticals Division and ICI Fibres Ltd., but whereas they qualified on only one or other of the two counts Dyestuffs Division did so both by export achievement and by making an important technological innovation. Only 18 companies or units of companies in Britain scored this "double."

Exports

The award recognised their success in selling dyes in more than 80 different export markets and also the discovery, introduction and subsequent development of the revolutionary 'Procion' dyestuffs, the world's first fibre-reactive dyes.

But this gives only an inkling of the effort involved, based on research, built up by the production, technical and commercial departments, and rounded off by a sales force whose markets range from the bazaars of the Far East to highly-developed countries with their own well-entrenched dyestuffs industries.

It has meant fighting for sales with the Germans, Swiss, Americans, Japanese and others in one of the most fiercely competitive sectors of the chemical industry—and beating them for business worth millions of pounds a year. Starting almost from scratch, and often in the face of formidable political, economic and financial difficulties, Dyestuffs Division have built up an organisation which now sells almost two-thirds of all their dyestuffs production overseas and which between 1962 and 1965 increased export sales of dyes by 40 per cent. In 1965 sales worth at least £100,000 were made in 40 different countries, and last year the value of all types of products exported was over £25m. This is the measure of the achievement.

The foundations were laid in the late 1940s, when on returning to peacetime operation after the war the Division decided to put a large part of its resources into an export drive. Many overseas users of dyes had previously been supplied by Germany—before 1939 the world's leading dyestuffs manufacturers—and Switzerland. Now the German dyestuffs business was at a standstill and few countries had the "hard" currency needed to buy from the Americans or Swiss. Markets were wide open. Demand was high, for people everywhere sought colour and brightness as a relief from the drab austerity of wartime. Here was Dyestuffs' opportunity, and they took it.

Products were made to suit the needs of particular markets, and sales teams were built up, trained, and sent to all the big dyestuffs-using countries. They had to deal with a wide range of industries, each with its special requirements, and they had a double job to do. First, to sell all they could of the dyestuffs available, which under existing conditions was not too difficult. Second, and just as important, to see to it that their new customers were so satisfied that the ICI name would come to mean as much in the dyestuffs world as those of the great pre-war manufacturers.

As war-shattered factories were rebuilt and more international currency became available these firms were bound to fight to regain their old markets and win others. When that happened, Dyestuffs Division wanted to be already accepted not only as the people who had stepped in to satisfy a temporary demand but as serious long-term suppliers who could be relied on for high-quality products, technological improvement and efficient service every bit as good as anything their competitors could offer, or even better.

The build-up continued throughout the 1950s as agents were appointed, marketing subsidiaries were formed and the selling range was extended. Today Dyestuffs have more than 700 people on overseas sales. In keeping with overall ICI policy almost all are nationals of the countries in which they work and are in one or other of the 44 different ICI subsidiary or associated companies, or with the various agencies handling Dyestuffs' products.

Except in Communist countries, where sales contact is directly between the State organisations and the Division, there is a local sales organisation in every market which has a dyestuffs-using industry. And in 24 of these countries local technical service experts and facilities are available to give customers an even quicker service than they can get from Blackley.

This growth has been achieved despite intense and increasing competition. Not only have the Germans, the Swiss and the Americans sought to regain old markets and capture new ones, but the French, the Italians, the Japanese and others have also joined the struggle. Dyestuffs Division have had to match them not only in sales techniques and technological improvement but in meeting continually changing demands. This has often meant anticipating changes in customers' requirements before the customers themselves were fully aware of the need for them and by studying trends in fashion and design. It has meant keeping up with or even initiating developments in textile technology and making full use of market research and similar techniques.

Their success can be seen in the value of their sales inside competitors' own home markets—America, France, Germany and so on—or in markets such as those of South-East Asia, which for reasons of geography or history might be expected to buy elsewhere than from Britain.

All this has demanded accurate forecasting of market requirements two, three or four years ahead; countless journeys by ICI and agents' salesmen to customers whose premises could be as varied as a giant American textile mill or the jungle hut of a batik craftsman in Indonesia; and by the patience and skill of technicians willing to spend days or even weeks solving customers' problems on the spot.

Based on Blackley, in Manchester, with some 16,000 employees there or at Trafford Park, Huddersfield, Grangemouth, Billingham, Wilton, Fleetwood, Derby and Ellesmere Port, the Division makes a wide range of products. These include nylon polymer, chemicals for polyurethane foams and lacquers, and rubber chemicals and organic chemicals, all of which are exported.

But the hard core of their business is the manufacture of colouring materials. About 4,000 of the 6,000 products in the selling range—the widest in ICI—are dyestuffs used by the cotton, wool or synthetic fibre industries, or in making paints, printing inks, paper, leather, rubber and plastics. How did they win the Queen's Award?

TESTING
Pigments are tested on a gravure rotary press for use in printing inks
Photographs: Ronald Chapman

MANUFACTURE
Left: A stage in the manufacture of 'Procion' dyes which are being fed to a delivery chute for further processing. *(Copyright: C.O.I.)*

ANALYSIS
Chromatographic analysis of dyes, a valuable tool in identification, uses differential rates of diffusion to separate out the ingredients of a given mixture

WINNING THE QUEEN'S AWARD

Throughout, Dyestuffs Division have had to contend not only with commercial competition but with political, economic and financial difficulties—in Germany and America, for example, with high tariff barriers which protect advanced and strong home dyestuffs industries; in India with growing local manufacture and an acute shortage of foreign exchange; and in Brazil with financial restrictions and rapid inflation. In Communist countries, State-controlled centralised buying calls for different selling methods, and Dyestuffs Division have been singularly successful in this field. The efforts of the salesmen have been backed by a before-and-after-sales organisation created as an essential part of the overall sales strategy. It includes, both in the UK and overseas, the holding of large stocks of finished products worth several millions of pounds to provide a prompt delivery service to customers, meeting special packaging requirements and keeping the various transport methods continually under review.

Equally important is a technical service organisation which operates on the premise that any customer who buys a Dyestuffs Division product has the right to ask for information and technical assistance. Many UK and overseas sales offices have their own technical service laboratories, with the main laboratories at Blackley. These are part of the Application Research and Technical Service Department—"ARTS"—and are staffed by specialists with experience in the many industries served by the Division. Every year the Blackley laboratories deal with over 35,000 technical service enquiries—some of them simple, some highly complex—and the 200 or so qualified scientists and technologists in the department make about 2,500 technical visits to overseas customers. About 1700 of these annual visits are concerned with dyestuffs applications. In the laboratories, specialised equipment and reduced-scale models of production machines make it possible to test dyes and other products under authentic conditions. New products can be evaluated and new processes developed. The most recent of the latter is the novel ICI high-temperature steaming process for the rapid and economical fixation of dyes on dyed or printed fabrics, equipment for which is now being commercially introduced by a number of machinery manufacturers under licences granted by Dyestuffs Division.

Another aid to customers—and to sales—is the unique Instrumental Match Prediction (IMP) Service which uses a digital computer reserved exclusively for providing dyeing and printing recipes to match any coloured pattern. All the customer has to do is determine the colour co-ordinates of the pattern by using a colorimeter and then send his enquiry, giving the co-ordinates, by the international telex to Blackley. Details are fed into the computer and the required shade-matching recipe is printed out for transmission back to the customer. A textile manufacturer in the Argentine, for instance, needing a dyeing recipe to produce a particular colour on a particular material would have his precise answer within hours. Enquiries from Europe, the Far East,

WINNING THE QUEEN'S AWARD

DYEING YARN
Wound yarn which has just been dyed under pressure in this circulating dyeliquor machine

PIGMENTS
This automatic muller (above, right) disperses the pigments so that their tinctorial (colouring) power may be accurately assessed

Australia and other overseas markets are as commonplace as from Britain—the total is now 30,000 shade matchings a year—and the service is also well used by textile factories in Russia. Their queries, channelled through the Textile Research Institute in Moscow, are telexed through to the IMP computer at Blackley, and the Russians have been eminently satisfied with the service.

Publicity, too, helps to boost sales. About 850,000 items of publicity material are sent overseas every year, most of it produced in at least six languages—English, French, Spanish, German, Italian and Portuguese—and sometimes in six others, including Russian, Serbo-Croat and Chinese. About 700 translations are prepared every year by Dyestuffs' own translators, and the Division take part regularly in overseas exhibitions and trade fairs.

Techniques

No matter how well organised and backed by publicity, a sales campaign only succeeds if there is something worth while to sell—and Dyestuffs Division have not only a well-established range of "traditional" products but also the new 'Procion' dyes.

These are the result of a major technological breakthrough. Their development in the past few years was the second achievement recognised by the Queen's Award.

More than any other factor it also established Dyestuffs as a major force in dyestuffs manufacture. Without the 'Procion' dyes the overseas sales drive would still have gone on, but would not have been so successful. Not only did customers all over the world want the new dyes—once they had been convinced of their advantages—but they became more aware of the other Dyestuffs' products. That was the 'Procion' double bonus.

For more than 60 years research workers sought a practical process for dyeing cellulosic fibres—cotton, linen and viscose rayon—by chemically reacting the dyestuff with the fibre. The breakthrough came at Blackley in the 1950s, when the work of Dr. W. E. Stephen, who is now retired, and Mr. I. D. Rattee, now professor of Colour Chemistry and Dyeing at Leeds University, led to the manufacture of the first three 'Procion' dyes—a yellow, a red and a blue. This completely new type of dyestuff could be reacted with any cellulosic fibre to give economical, bright shades with high fastness to washing. It was a revolutionary event, but for Dyestuffs it was only a starting-point.

More dyes of the same type were produced as a great research effort was organised to exploit the invention and to extend the range of processes which could make use of the dye. A clear lead had also to be maintained over competitors, who were bound to make their own reactive dyes if it was possible to do so by methods not covered by ICI patents. So work went into protecting the invention by discovering and registering new methods of making the dyes and new processes for using them.

Today all the major Continental dyestuffs manufacturers have reactive dye ranges—but Dyestuffs research and development effort has kept ICI well ahead. The Division have increased and improved their range until it covers more than 70 colours, each meeting a particular demand for shade, colour fastness or end-use. Many of these have been added to the sales range in the last three years, and today the Division sell more 'Procion' dyestuffs than any other class of dye. And about 90 per cent of them go overseas.

The spectacular growth in 'Procion' sales resulting from the Division's sustained, energetic exploitation of its invention of reactive dyes made it clear at an early stage that new manufacturing capacity would be needed, and a big new plant, solely for the manufacture of 'Procion' dyes, was designed and built. This plant, at the Division's Trafford Park Works, came into operation early in 1963; it incorporates the most up-to-date know-how in chemical plant design, with many novel features in layout and automatic control.

Textile manufacturers and designers have been greatly influenced by the introduction of more and more new dyes. This in turn has influenced fashion, both in the use of materials and the choice of colours. Clothes are brighter and patterns are bolder. The "Pop-art" fashion trend which has spread from Britain all over the world might never have started but for the work done on 'Procions' at Blackley and imaginatively exploited by ICI customers.

The lesson in all this for Dyestuffs has been that success in such a technically advanced and commercially tough world as theirs can only be achieved by a team effort stretching right through from long-term research to sales. Technology and commercial expertise become indivisible in the struggle to gain and hold business. Everyone must be aware not only of the importance of his own contribution and how it fits into the pattern, but also of the work of others. There is no room for complacency in today's quickly-changing conditions—not that there ever was—and the constant requirements of basic research and invention have to be harnessed to flexibility in development and sales. No possible sales outlet can be ignored, no market neglected, and the man who yesterday worked willingly on technical service or production must be just as ready today to turn to market research or to long-term sales planning. Given that sort of outlook, the Dyestuffs Division should win yet more Queen's Awards.

SERVICE The printing properties of many thousands of dyestuffs are systematically examined in the course of Dyestuffs Division's technical enquiry work for their numerous customers at home and abroad

represented than any other Division, but the amount of IMI copper used in the house exceeds in value any other single raw material.

In choosing products for our house we worked on the basis that everything we used must be of a reasonably commercial nature and we told Divisions we would only consider products for which fairly definite marketing plans existed. We waived this rule for two special items, both of which are still in the development stage. These are the prefabricated 'Perspex' bathroom unit, of which more in a moment, and the gypsum block wall from Agricultural Division in one of the bedrooms.

Bilsland: *How long did it take you to build, and why a traditional design?*

Casey: We started work a little more than two years ago, obtained the official approval of the European Council, as it then was, in October 1964, and engaged our architect, Mr. James Connell, who obligingly returned from the United States to undertake this commission, in January 1965. Plans were finally drawn up about June of last year and building began in September.

The basic design of our Irish Home is a T-shaped bungalow with the living area running along the top of the T and the sleeping area and garage in the vertical. I would describe the style as "modern traditional." Wicklow County Council, when giving planning permission, naturally insisted that the structure should blend into the natural surroundings, but in any case we were against anything too extreme. We all felt that a conventionally-built house would have the widest appeal and would at the same time show how ICI's latest building products can be used in any construction. Obviously our bungalow belongs in the custom-built category, but everything in it will give visitors ideas for their own homes, and many of our products cost no more, sometimes less, than existing products and at the same time contribute to an overall improvement in living and building standards.

People are taking a much greater interest in the materials which go into their homes and are becoming much more discriminating. Nowadays, for example, many householders know quite a lot about the merits of different forms of central heating. We would like to see them taking an equal interest in items such as piping and gutters, to have them asking their builder for pvc guttering, for example, because it never needs painting, or for polythene cold water pipes because they won't burst in a freeze-up. ICI has a high reputation for good quality products, and I think people will be interested to learn what ICI has to say about the newer materials used in building today.

Bilsland: *What do you feel to be the best features of the house?*

Casey: It is hard to single out particular features, but our bathroom has certainly aroused enormous interest. It was specially fabricated for us by the ICI Building Development Group, and the whole of the bottom half of the room, including bath, basin, walls and floor, was moulded from ICI 'Perspex' and delivered to the site in a box!

Another unusual feature is the use of two separate heating systems. This was not, as you might think, merely a means of publicising rival ICI products. We feel there are real advantages to be gained by installing different systems for the living and sleeping areas. For the bedroom wing we chose Nobel Division's new 'Flexel' ceiling heating system because it is cheap to install and to run, takes less than half an hour to heat up a room, and can be switched on and off at will. We put IMI's new high-output 'Delarna' convector heater in the living area because in practice this could be linked to a back boiler. Thus two systems could give flexibility, low running costs and—very important—low installation capital cost.

Bilsland: *I like the colour schemes, especially in the living room. Who did them?*

Casey: Yes, that is the immediate comment from almost all our visitors. John Lupton of Paints Division's Colour Advisory Service at Slough drew up the specifications in collaboration with the architect, and in addition to the colours for walls, carpets and such-like, he chose all the furniture and furnishings for us. I too like the living room best. I think the designer has been wonderfully successful in blending the colour scheme with the superb scenery one can see from the picture windows.

Bilsland: *What sort of response have you had?*

Casey: We have been delighted, indeed somewhat overwhelmed, by the interest the ICI Irish Home has aroused. At present it is open during the week to the building industry and at weekends to the public, and each Sunday we have to turn hundreds away. We have a resident representative at the house, John Mortimer, an ex-Agricultural Division man, who retired recently from Sheffield. He and his wife Mary at present live in a caravan in the grounds and will be moving into the house for the winter when it is closed for visitors. Before we open it again next summer we shall probably do some redecoration, put up some of the 1967 'Vymura' patterns on the walls, and incorporate any other new products that come along. We will also be doing some more work on the garden. At the moment we think that three years will be about the life of the house as an ICI showpiece, then we plan to sell it.

One of the most satisfying things about the project has been the reaction of the staff of ICI (Ireland). When we asked for volunteers for duty at weekends to show the public over the house the whole office volunteered. Naturally we couldn't make use of everybody but about two-thirds of our staff are involved as guides, and many of them are people whose jobs do not normally bring them in touch with the public.

Now they know the house from back door to front door and exactly where every product is. They are proving invaluable—2,000 people are visiting the house every weekend and looking after such large numbers has been a great challenge which has been enthusiastically taken up.

Bilsland: *You mentioned earlier the marketing of building products—how will the house fit into future plans?*

Casey: The big effort this year is due in the autumn. Five of the big builders' merchants in Dublin will be staging exhibitions of goods and materials used in the ICI Irish Home. This will be the first time anything like this has been tried in Ireland, and if it is successful we shall consider expanding the coverage in 1967 to towns all over Ireland.

We have set ourselves an ambitious target for sales to the building industry, which is the second biggest market in Ireland. In the first two years, this year and next, our emphasis must be on the industry, with some consumer interest, but in the third year we may well use the house as the focal point for a more strictly consumer promotion. But in general our plans can be summed up in our endeavour to make the "ICI Irish Home" a symbol of quality and value for money.

Left and above: Employees of ICI (Ireland) and their families were invited to view the Irish Home on the Sunday before the official opening

SELLING FOR ICI: AGRICULTURE

Out of every ten pounds Britain spends on imports three pounds goes on food. The total food import bill last year was £1530 million, of which roughly £900 million was for temperate zone foodstuffs, about £200 million of which could be grown at home. To reach this target will call for substantial effort and more concentrated fertilizers, better farm management, and new investment in farm buildings and machinery. The ICI agricultural representative, backed by research on ICI's five farms and the 500 commercial farms costed by ICI, is a key man in the drive for greater productivity on the farm. Here we show a typical day for Martin Hutchinson, Agricultural Division's man in Berkshire since 1964. A graduate of Wye College, he worked on farms in his home county of Hertfordshire, in the Cotswolds and in Sweden before coming to ICI in 1961. After training he was a farm recorder at ICI's Henley Manor Farm Somerset and then worked as assistant to Gilbert Kennedy, agricultural representative in Gloucestershire.

8.30 am His day begins at his desk. The morning's post dealt with, he sorts documents needed for the day's visits. He works from home, near Newbury and fairly central for his territory. Farmers and agents may phone with a query at any time of day, and when he is out his wife Jenny takes a message.

9 am Off on the first journey of the day. Hutchinson makes an average of between 15 and 25 visits a week and covers about 1500 miles every month. His first call today is at Wasing Place Farm, Aldermaston, where with farm manager David Dearden he examines fields of oilseed rape, a new crop for this dairy and arable farm. More and more southern farmers are using oilseed rape as a break between corn crops. It requires particularly heavy fertilizer treatment – and also provides scope for pre-emergence sprays from Plant Protection. Next he visits Goodenoughs of Reading, one of ICI's largest agents in the area, to discuss with managing director Mr. Roddy Messer plans for a meeting with their field staff and arrangements for parties to visit ICI's Henley Manor Farm and Jealott's Hill Research Station.

11.15 am Examining winter wheat ears for signs of Yellow Rust on David Castle's farm on the Newbury–Wantage Road. This cereal disease has been widespread in the area this season and is causing concern. Grassland here has been treated with ICI's 'Nitram' to improve quality and yield. Opposite, Hutchinson puts up a board to draw attention to this demonstration, part of the build-up of an intensive beef enterprise on this mainly downland corn farm.

12.30 pm For lunch at the Crown and Horns, East Ilsley, he joins Development Officer Peter Morton and Jim Rance (Animal Health Products) to discuss details for an ICI farm walk to be held at Chieveley. After lunch he calls at the More brothers' farm at Burghfield, one of 500 farms in Britain costed by ICI. With Morton, who costs the farm, he goes over ICI proposals for a beef project and its effect on the farm plan with the owners. He also sees an ICI field trial for which Peter Morton is responsible and with which the More brothers have co-operated. This shows the difference in yield between cereal treated with nitrogen top dressing and an untreated crop.

4.15 pm One of the agricultural agent's staff had reported that a Mr. Marsh had some problem fields at Hampstead Marshall and wanted advice. Hutchinson calls, arranges a further visit.

5 pm Last call is to take soil samples of the water meadows on Mr. E. D. Hill's 200-acre dairy farm in the Kennet Valley. If the water meadows can be made productive, the herd could be increased from 90 to 140 cows. Acting on ICI advice, Mr. Hill is planning a reseeding operation using the 'Gramoxone' minimum cultivation technique. After this it's home, with the day's reports still to write. These will go to the Area Sales Office in London.

2.45 pm Cereals are the main enterprise on Lord Iliffe's 2500–acre Yattendon Estate, managed by Tim Culley. The change to ICI No. 3 fertilizer for early-drilled spring corn also suits the spring beans, a useful crop which is making quite a comeback in the county. Eighty acres were under spring beans at Yattendon this year. Soil analyses discussed confirm the proposed fertilizer programme.

PEOPLE
PROJECTS
PRODUCTS

36 times over . . .

Girls sort the mounds of ICI stock forms at a City branch of the Westminster Bank, one of four banks handling ICI's £60 million loan stock issue. Oversubscribed 36 times, this issue brought in applications for £2176 million. This was over double the figure put up for ICI's £50 million issue a year ago, itself a City record at the time. More than 440,000 applied. Some 241,000 were existing holders of ICI shares or loan stock, and they applied for over £1818 million. Ninety-five per cent of the issue went to these stockholders, all of whom received a part of their application. The remaining five per cent was allotted to the public and drawn by ballot.

Daily Express photograph

A bringer of more change in the last few decades than any other single industry, the chemical industry has itself changed profoundly in the process. New patterns, new purposes are emerging, based on different sources of raw materials and different production techniques. As a result, the industry is already far more complex than it was before 1939, while the rate of change continues to accelerate. But even today many people, even perhaps some in ICI, do not fully appreciate what industrial chemistry is about in human terms. To put these changes into perspective we asked John Wren-Lewis of Research and Development Department to write a series: *Reports from the Frontiers of Change*. In these reports he will explain the significance of new developments in the industry both for the Company and the country, and will single out the growing-points of ICI research. In this first article he discusses the biggest, most fundamental change in recent years.

The Petrochemical Revolution

Photograph: Michael Taylor

ONLY during the past two centuries or so has the distinctive capacity of the human species—the capacity to invent and create—begun to find really large-scale expression. One of the mainsprings of this radical change has been the development of chemistry—the realisation of man's power to transform the materials of nature into new substances with new combinations of properties for human purposes.

Scholars have speculated about the possibilities of transforming materials from very ancient times. But although alchemists, from ancient Greek times to the Renaissance, prepared the way for modern chemistry by developing practical skills like grinding, crystallisation and distilling, they made little real progress because their attempts to work out theories of chemical change were hopelessly muddled up with aesthetic and psychological considerations. They believed, for example, that the purification of materials in the laboratory was directly linked with their efforts at moral purification, because they thought of the elements of which the world was composed—earth, air, fire and water—as spiritual principles rather than as simple physical materials. Again, a typical alchemical theory was that gold might have been formed in the earth by the solidification of sunlight after it had been trapped by flowers and turned to nectar, then processed into honey by bees, then hardened by contact with the earth into sulphur; similarly it was thought that silver might have been formed from moonlight, trapped into dewdrops and then changed by contact with the earth into quicksilver, finally being solidified to silver by pressure! Ideas like these reveal a sense of magical identification with nature, and a logical confusion of material, aesthetic and moral considerations, which made real down-to-earth understanding impossible.

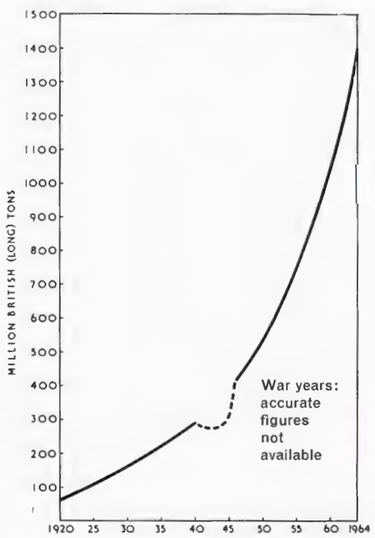
A key factor in the revolution which turned alchemy into modern chemistry was the recognition that the immense variety of nature is made up of combinations of elementary physical materials like iron, carbon, oxygen, nitrogen and so on—less than a hundred altogether, with only a couple of dozen of any widespread importance, and carbon the most important of all, though by no means the most plentiful in the overall composition of the earth. Given this understanding, chemists very rapidly began to work out, during the nineteenth century, hosts of ways of making valuable substances artificially from cheap natural raw materials. Even more important, they found ways of making countless new substances, quite unknown in nature, with interesting new properties. The coal seams which had provided the fuel for the first stages of the

Chemical plants are tending to look more and more like oil refineries, because petroleum is becoming the chemical industry's major raw material. This is the No. 4 cracker at Wilton for producing olefine hydrocarbons from naphtha

industrial revolution now began to have a new significance as cheap sources of carbon for a new adventure in human creativity: synthetic chemistry.

Today chemical manufacture has reached a scale scarcely dreamed of even in the heyday of the nineteenth century, and it is very largely a matter of manipulating four of nature's chemical elements—carbon, hydrogen, oxygen and nitrogen, the last two freely available in the air all around us. Among the pioneers who laid the foundation of the modern chemical industry it is important to acknowledge the scientists and engineers at the end of the nineteenth century who worked out practical ways to liquefy air (Andrews, Dewar, Carl von Linde). Later, too, others devised ways of combining atmospheric nitrogen with other elements without prohibitive expense (notably Fritz Haber, who worked out the process for combining nitrogen with hydrogen to give ammonia, an important starting-point for making fertilizers and many other chemicals). Hydrogen is equally readily available in water, together with oxygen. Another foundation stone of modern large-scale chemical manufacture was the group of processes worked out just before World War I for getting the hydrogen out of water cheaply by using coke to take up the oxygen. This, incidentally, brought in the fourth and most crucial element, carbon, which would end up as carbon dioxide, useful for refrigeration and fire extinguishing or, more important, as slightly more complicated chemicals such as methyl alcohol, CH_3OH, which could be used to initiate more involved syntheses. These coke-and-steam processes provided both hydrogen (for making ammonia and for many other reactions) and also a valuable cheap source of usefully-combined carbon to supplement the various carbon compounds distilled from coal tar.

PETROLEUM CONSUMPTION: 1920–64



The rise of the modern chemical industry has gone hand in hand with the growth of petroleum production, although at present the chemical industry of the world uses only tens of millions of tons a year, while fuel uses amount to hundreds of millions

The vast expansion of more recent years, however, has been possible only because chemists learned to use an even cheaper source of carbon in which it is already combined with hydrogen—petroleum oil and natural gas. Unlike any other minerals, these can pump themselves up out of the ground and can be transported continuously over vast distances by pipelines. Like coal, petroleum and natural gas were exploited first as fuels. This is an extremely important factor in the economics of using them. Just as the first phase of the chemical industry was conducted, during the late nineteenth century, on a shared use of the raw material coal with those who wanted it for solid fuel or coal gas, so the new phase is being conducted on a shared use of the new fluid hydrocarbon raw materials. That is why the petrochemical revolution began in North America, where the 1920s saw huge developments of indigenous petroleum and natural gas, geared to a great multiplication of houses needing light and heat and an even greater expansion of transport based on the internal combustion engine.

In Europe, where coal was plentiful and petroleum was not, it seemed possible up to World War II that it might be economic to make artificial petrol by hydrogenating coal, and it was from this starting point that European industry learned sufficient know-how of this general field of chemistry to be able to join in the petrochemical revolution in the post-war years without too much of a handicap compared with America, and even with some advantages. Today it has become clear that petroleum oil and natural gas are readily available on a scale far in excess of the world's fuel needs on any reasonable projection, and are likely to provide the main basis for chemical manufacture for the foreseeable future.

Indeed, the time will come when we shall regard it as highly wasteful to use valuable sources of carbon like these as fuel at all, given the development of other sources of energy like nuclear fission and fusion. At the moment, however, fuel uses vastly outweigh chemical ones, and in any case the two interests can often go hand in hand. Thus ICI has found it possible and worth-while to go into the petrol business alongside its petrochemical manufacture in the North-East.

The crucial operation here is the process known as cracking, whereby the complex mixtures of hydrocarbons in oil are broken down by heat and pressure to give simpler hydrocarbons. Inevitably this process involves the redistribution of hydrogen atoms among the available carbon atoms, and the Americans found when they first developed the process in the 1920s that one of the major products was the "unsaturated" or "olefinic" hydrocarbon ethylene, C_2H_4, which they used in those days to make ethylene glycol for antifreeze. (Since then a vast new use for ethylene glycol has opened up in 'Terylene' manufacture, while ethylene itself is required on an enormous scale for making polythene.) Subsequent investigation, some of it in ICI, showed how careful control of the conditions of temperature and pressure in the cracking process would make it possible to vary the products in many different ways, and this is one of the key features of the modern petrochemical industry. The oil industry does the same kind of thing, starting from crude oil, although it is naturally less concerned than is the chemical industry with the purity of its products.

Natural gas has not been an important raw material for British industry in the past, but it may well be in the future if explorations in the North Sea are successful, and we are well prepared for this possibility in ICI, having already become thoroughly involved at Billingham in the key process for handling hydrocarbon gases, the process known as steam reforming. In effect, this process uses hydrocarbons to do what coke used to do in the old coke-steam processes, and it has the immense advantage that it uses the hydrocarbons as sources of hydrogen as well as of carbonaceous compounds. In the old coke processes, in other words, the hydrogen all came from the steam, but in the modern ones it comes from the hydrocarbons too. And if air is mixed in along with the steam and hydrocarbon gas mixture it is possible, with the right catalyst, to get carbon dioxide (which can easily be separated out) and a hydrogen-nitrogen mixture all ready for ammonia manufacture.

One important achievement of Agricultural Division research in recent years has been to work out how to apply the reforming process, which was originally developed nearly forty years ago for natural gas and gases from oil refineries, to the liquid hydrocarbons of petroleum fractions, and the resulting process has been so successful that it has been widely sold for providing gas for heating and lighting from petroleum rather than from coal.

In general, it is certain that for many years to come there will be research, in ICI and all over the world, on new ways of playing tricks with the hydrocarbons that come streaming out of the rocks ("Petrol" comes from the Greek word for "rock") to turn them into materials that can be used in chemical synthesis, even though the ultimate products of the chemical industry may change enormously as new inventions are made.

Petroleum and natural gas, unlike other minerals, can pump themselves up out of the ground and can be transported over great distances in pipes. ICI buys petroleum naphtha from refineries in many parts of Europe, and tankers discharge it at jetties like this one on the Tees. ICI's associated company, Phillips Imperial Petroleum, also imports its own crude oil, the distilled products of which are shared between various chemical and fuel uses

Harold Ingledew

ABANDON SHIP!

On 20th June 1915, at the age of fifteen-and-a-half, I signed indentures to go to sea as an apprentice, and soon afterwards, at two o'clock on a July morning, sailed from Middlesbrough in the s.s. *Bilswood* bound for Buenos Aires. The ship was on her maiden voyage, carrying a full cargo of metal pipes from Cochrane's Wharf.

There were four apprentices, two of whom had about two years' sea service, one other new, like myself, but 17 years of age—while I was the youngest. My apprenticeship was for four years and my pay was to be £40—£4 for the first year, £6 the second year, £8 the third year and £12 the fourth year. We received 12s. a year in lieu of laundry and 30s. a month war risk bonus.

I have a very hazy recollection of that first run down the North Sea in the care of a Trinity House pilot, of all the ships I saw at Dover, of hearing that many ships had been sunk, of destroyers scuttling about—there was so much to see it was like a dream. Finally, away down the English Channel and then out into the Atlantic. It took us thirty days from Middlesbrough to Buenos Aires at a maximum speed of eight knots—and during those thirty days I learned many things, principally how to look after myself.

I always recall Buenos Aires as my first foreign port, the wonder of going up the river, of finally going ashore for the very first time, with very, very little in my pocket, and going to the seamen's mission. At that time a famous character was in charge at the mission—a fighting parson, known world-wide—Canon Brady. He would box anybody on two legs.

My good luck, as far as the war was concerned, held out until April 1917. We had been to the Bristol Channel and loaded a part cargo of coal and, in other holds, quartermaster stores of all kinds for the army, worth about £2m. and bound for Alexandria.

The ship called at Valetta in Malta for orders and escort, and we were duly given a sloop which escorted us so assiduously that we felt pretty safe as we sailed through the Mediterranean. On Saturday, 10th April, we arrived off Alexandria to find the port closed to shipping because of rough weather, which persisted all day Sunday. We patrolled about five miles offshore. Then on the Sunday evening the sloop signalled that she had been ordered back to Malta and we were to continue patrolling at slow speed until the port was opened. Wishing us good luck, she vanished into the gloom.

On Monday morning I was on watch: my trick at the wheel was from 10 o'clock to noon. It was warm but still blowing, with quite a rough sea and swell. At ten past ten, with the captain and chief officer on the bridge and the ship still going at slow speed on course, I felt a shudder go through her. I saw the startled look on the captain's face as he ran to the wing of the bridge and heard him say to the first mate—"She must have run aground."

Then the chief engineer came tearing up the ladder to the bridge shouting "Captain, we have been torpedoed! I saw the torpedo hit us just abaft the engine room on the port side, but it did not explode."

Already the ship was beginning to go down by the stern, with a decided list to port, and the captain gave the "Abandon ship" signal on the steam whistle. He told me to go to my lifeboat but to collect a life-jacket first.

Off I dashed to my quarters, grabbed my lifebelt and returned straight to the boat deck. By this time the ship was so much down by the stern that the bulwarks of the after well-deck (between the bridge and the poop) were awash. I was in the first mate's boat on the port side. When I got there the mate had already lowered the boat into the sea—but it was empty, and he was frantically shouting for someone to get into her. The falls (the ropes for lowering the boat) were still hooked fore and aft, and lines from the stem and stern were still made

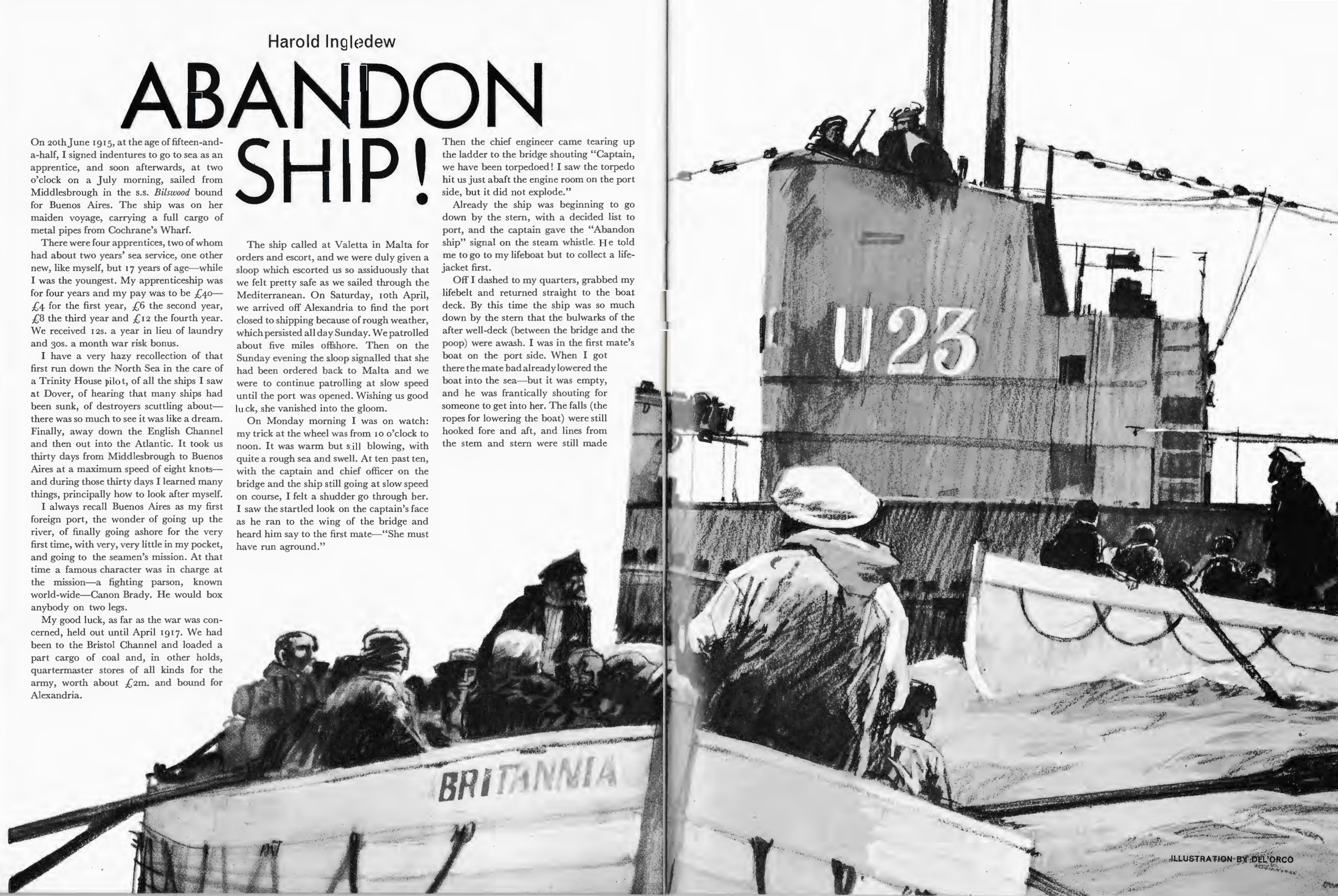


ILLUSTRATION BY DEL ORCO

fast to the ship. He was shouting at the top of his voice, but no one seemed inclined to obey. Meanwhile the ship was still making headway. The lifeboat was rising and falling in the swell. When it was on top of a rise, I calculated there was roughly about six feet from it to the top of the boat deck. As it rose to the next swell, I jumped straight in!

The mate yelled orders at me: "Get to the after end and release the fall hook"—which I did. "Go to the forrard end and release the forrard fall." I scrambled forward and, as the boat rose again to the swell, unhooked the block, and was very nearly hanged as the fall ropes fell around my shoulders. However, I managed to swing the falls inboard, and they were caught by the mate on the boat deck and hooked back clear.

"Get back to the tiller and keep her alongside," he then shouted. The lifeboat came alongside, and the men came swarming down the lifelines. I looked at the ship. She was sinking fast by the stern, heeled right over to port. I saw the captain with a lifebelt on in the wing of the bridge. He had his dog, which he threw into the sea, and then he jumped with a lifebuoy after it. And now the ship stood right up on her stern. The boilers blew up, and I saw the last of the stern disappear slowly under the waves.

An armed trawler was making its way out from Alexandria towards us. Soon the captain was picked up and the lifeboats were towed into the port. We were cared for by the Soldiers' and Sailors' Mission.

After a fortnight in Alexandria, we four apprentices, in the care of the second mate, were put on board the s.s. *Britannia* and sent home as distressed British seamen. We called at Malta for orders and were warned that submarines were operating around Cape Bon. Exactly three weeks from our first sinking, and midway between Malta and Cape Bon, we caught it. On 2nd May there was a terrific explosion on the starboard side amidships. I ran to my cabin, put my lifebelt on, grabbed a few packets of cigarettes I had been given in Malta, and doubled back to the boat deck to join my fellow apprentices. The second mate ordered the four of us into the boat and we quickly slid down the lifelines, then others after us.

The ship was sinking fast by the stern, and finally, when we were clear, I noticed four boats in the water, including a small jolly boat. Later I learned the torpedo had torn a hole 30 ft. long in the starboard side and that one lifeboat had been smashed.

"Where is the Captain?"

As soon as the gun on the poop of the ship disappeared beneath the waves the submarine, which had kept clear until then, came towards us. She was armed with a 4·7 in. gun, and as she closed with the boats we saw the last of the stern of the ship slide underneath the sea. I noticed the small boat pulling clear, and then I heard the submarine commander shout through a megaphone: "Where is the captain?" Immediately a big, hefty fireman in our boat jumped to his feet, a boat axe in his hand. "I'll split the head of any man who speaks!" he yelled.

The U-Boat commander waited, then drawing a big pistol from its holster, and with the gun trained on the lifeboats, he said, "I will give the captain two minutes to stand up, or I blow you out of the water." At which the big, hefty, brave fireman once again jumped to his feet and, pointing to the small boat, said, "There he is, Commander"—and sat down like a deflated balloon. By this time of course our captain was on his feet. He was told to pull alongside the submarine and was "invited" by its commander, in perfect English, to come on board. Then the submarine commander turned to our boat, and seeing the wireless officer sitting in his uniform asked him who he was, and being told, invited him on the submarine also. As the wireless officer reached the conning tower, his "host" took off the binoculars slung round his neck and handed them to "Sparks," with a warning to keep a good look-out while he chatted with the captain. "Where are you from, Captain?" asked the commander. "From Alexandria via Malta," was the reply. "Better if you had stayed in Malta, Captain." Then, "You are an hour late. Where have you been? I have been waiting for you." Then, finally, "Captain, you had better go below, where you will find some companions—but first say cheerio to your crew."

One of the decent ones

So the captain turned and wished us all good luck, and we gave him a cheer as he went below, with the wireless officer following. The submarine commander then addressed us through his megaphone, advising us to stay where we were, that he had sent out an s.o.s. for us, and he was sure we would be found. Finally wishing us good luck, with a wave of the hand, down he went, the conning-tower hatch was shut and the submarine submerged. One of the decent submarine commanders!

After about four hours we were picked up by a French trawler and taken into Bizerta in Tunis, where we stayed two nights. We each received a suit of clothes, a shirt and shoes before being put on a French ship for Marseilles. We stayed there one night and were then sent by train across France, a journey of 19 hours, to Paris. Once arrived, we were kept there one week, apparently because of excessive submarine activity in the English Channel. One week in Paris—with only the clothes I stood in, and no money! Finally we were sent to Le Havre and at night were shipped across to Southampton, where I was given rail tickets home and a few shillings for expenses.

My mother, who had been worried almost to death, hardly knew me. After a week at home the Company transferred my indentures and I was packed off to sea again.

But I must hurry on. Twenty-five years afterwards I was again to live through another war at sea. I duly obtained my master's certificate and in course of time became chief officer of a new 10,000 ton vessel, the M.V. *Derryheen*, in January 1942.

We left Burntisland, where she was built, and sailed in convoy to the USA, where we loaded war material of all kinds for the Eighth Army, including two locomotives shipped on deck. We finally left Philadelphia, with orders to steer due east from the coast for 24 hours, then SE for 24 hours, and finally south before making round the Cape of Good Hope for the Suez Canal.

On 21st April the captain and I felt we were well clear of normal submarine activity and so I decided to go to bed that night in pyjamas instead of the clean pair of white flannels and white sweater which I usually wore in case of trouble.

At 3.15 a.m. there was a shattering explosion which shook the ship, and all the former memories came crowding in. Without switching on the light I jumped out of my bunk, put my uniform over pyjamas, pulled on my life jacket—and the "Abandon ship" signal was sounded on the siren.

I dashed on to the boat deck, where my boat's crew were assembling. Everything was in perfect readiness. The ship was afire in No. 5 hold where the torpedo had struck, with the derricks all twisted, and she was sinking very slowly by the stern.

I shouted to my crew to wait, ran back to my cabin and grabbed about 2,000 cigarettes from my settee locker, some boxes of matches, a ½ lb. tin of tobacco and some cigarette papers. I pulled my raincoat from the wardrobe, then dashed for the boat deck. All was quiet, but the ship was fairly well down by the stern and listing to port.

I managed to throw the cigarettes down to the bosun, who was in my boat, then I slipped across the boat deck and saw that the starboard boats had gone. This meant I was the last man on board, so I went down the Jacob's ladder (a rope ladder over the side of the ship), and as the boat came up on the swell I dropped. In doing so I fell and hurt my left shoulder, and I think I passed out for a moment or two. However, I struggled aft to the tiller and was on the point of giving the order to cast off when a cry came from the boat deck "Wait for us!"

ABANDON SHIP! *continued*

and I saw the two radio officers, whom I naturally thought had gone in the starboard boats they were assigned to. Down the Jacob's ladder they came, we grabbed them, and I gave the order to cut the forrard painter and pull on the after painter.

The ship was stopped, and we drifted clear of the stern. Just then I heard the engines of the sub away to port and gave orders for silence. The next moment there was a terrific explosion right amidships, where our boat had been a few minutes before, and a second torpedo did its work very quickly. Down went the *Derryheen*, stern first. For the third time I watched a ship go to its grave.

700 miles to go

We were roughly about 700 miles east of Charleston, South Carolina, and the captain suggested we make for there.

We set sail with a light following breeze. At about 3 p.m. that day a flying-boat from Bermuda saw us, and after dropping all kinds of bombs well clear of us, landed on the sea near the third officer's boat, which had only nine men in it. These were taken off by the flying-boat and the lifeboat was scuttled. At that time the weather was fine, but when the seaplane returned just before dusk the wind and sea were rising, and it was unable to touch down on the sea. It circled once or twice and then left.

I had a motor in my lifeboat and the second engineer as one of my crew. The lifeboat, because it was new and made from wood which had not yet swelled, was leaking badly, and it was a case of baling regularly. The engine was completely salted up and the engineer could not get it to start. With the lugsail and jib set we were gradually outstripping the captain's boat in sailing, so I turned back and offered to tow him, even though we were without the engine. I towed him all night—with his sails also set—but later the rope broke, so I waved him goodbye and set out for the distant coast on our own. Gathering various scraps of paper from the men on which to record our daily log, I also took stock of what we had on board to keep 12 men going. I found we had about 20 gallons of water, a tank of ship's biscuits, some tins of condensed milk and some chocolate. I rationed the water immediately. For 36 hours it rained more or less all the time, blowing on the starboard quarter, and I never slept a wink.

After the second day the boat was leaking much less, the wood having swelled and tightened the seams, so the need to bale was not so constant. I rationed the cigarettes each day but found I was short of matches, most of them being wet. Having a gallon can of colza oil (a seed-oil used in lamps), I made two "duck lamps," using plaited bandage out of the first aid box as a wick and condensed milk tins with a hole in the centre to pass the wick through. When two were lit and placed in a bucket, with a flat metal bar jammed across the top of the bucket on which to stand an ordinary flat biscuit tin filled with water, I could boil water. It took about two hours. The first time the bosun and I sat up all night preparing this and gave the chaps hot chocolate made by dropping in some of the bar chocolate and condensed milk; it provided them with a nice surprise.

My ration of sleep each day was from 6 a.m. to 8 a.m. only, and I was up every night while the others slept. I kept my log going each day, noting wind direction and force, weather conditions and an estimate by "dead reckoning" calculation — the only kind possible without observational instruments of distance sailed.

On Sunday, 26th April, I had a most wonderful experience. The wind gradually died away to a flat calm, the sea was like glass, with no swell, the sun was hot and I made everyone get their clothes dried; also we spread the canvas boat cover over a spar to form an awning and overhauled the lug and jib sail and running gear. I gave extra drinking rations, and during the afternoon had the men all lie underneath the awning.

There was absolute silence, a profound peace that could almost be felt. Most of the men were asleep.

I was sitting in the stern, figuring how far we had yet to go, when suddenly I seemed to hear the most beautiful singing coming from the westward, rising and falling and moving slowly to the east, until it swelled like a heavenly choir singing the Hallelujah Chorus, and then gradually fading away in the east. It was an inspiration. About 5 p.m. the wind came away fresh from the north-east and I breathed a prayer of thankfulness. The days continued and I recorded happenings in my scrap log.

Thus, on Thursday, 30th April:

"Strong current or tide fell with us this morning, and I concluded we were in coastal waters. Noted change in seaweed, less gulf weed and more kelp about. Pumped all gasoline overboard, using stirrup pump, owing to excessive heat of sun, in case of fire. Sighted exceptionally large shark about 3 p.m. Full moon tonight and strong tidal effect, boat speeding along with wind dead astern, lugsail out to port and jib to starboard. At midnight everything going well."

On Friday, 1st May:

"At 2 p.m. sighted four-engined American plane, gave smoke signal but no reply. Shoal of porpoises almost alongside boat. Noticed several baby ones swimming close to their mothers. Larger fish covered with marine growth.

3 p.m. Sighted seaplane, gave smoke signal, but no reply. 4.50 p.m. sighted vessel on port bow, altered course and brought her dead ahead. Gave last remaining smoke signal.

5 p.m. HMS *Polyanthus* (corvette) alongside.

5.05 p.m. All aboard and thank God. Lifeboat taken in tow. Taken into Charleston, South Carolina. Total distance sailed approx. 530."

Les 24 Heures du Mans

Peter Allen

How do you identify a great sporting event? To me, the Derby, the Cup Final, a test match at Lords, the Indianapolis "500" motor race, the Masters golf tournament at Augusta in Georgia – all of these are great sporting events, yet all totally different. But they all have something in common, something in the air, something that sends you inside the gates with a quickening heart, because you *know* that great issues will be decided, because you *know* that this time there will be no hanging back or lackadaisical performance – there is too much at stake – and seldom are you disappointed.

This year Tom Corbett, a friend from Plastics Division, and I decided we would go to Le Mans, he an old hand and I for the first time. This is the great sporting event perhaps above all others in motor racing, partly because it now has a venerable history, partly because it has been the scene of fearful triumphs and appalling disasters, more perhaps because it is the most grindingly demanding motor test of all, and also because it is one of the most tremendous holiday spectacles of France: 300,000 people throng the circuit, a whole village of shops, bars, restaurants and sideshows springs up, and thousands set up tents or sleep in cars or buses. The crowd is a mixture of all sorts, some fairly primitive, but no more so than the crowd at Indianapolis or Brands Hatch. I cannot imagine any other occasion on which I would even contemplate sleeping a few frowsty hours in a stone cold bus, and even now it seems "a thing to have done rather than a thing to do."

But we also struck lucky because we ran into friends in the "Motor" box right above the Porsche pits, and with their friends from Smiths' Industries – who had a luxurious caravan nearby – they plied us with food and drink, enabled us to sit down from time to time, gave us a splendid view of the race and saved us from some very bleak and exhausting periods.

Well, what of the race? The start is a wonderful sight, the 50 or so cars lined up in front of the pits, pointing at an angle up the course, the flag of France carried ceremonially along the road by Boy Scouts for Mr. Henry Ford, who had been invited to start the race; the drivers lined up across the way ready to sprint across when the flag falls; and beyond, the huge crowd

The historic crash at White House Corner in 1927, from which one Bentley emerged – to go on and win. From a painting for "Autocar" by F. Gordon Crosby. Below: Sunday morning at the Dunlop bend, with a Porsche in the foreground

A Bizzarini in trouble at the Mulsanne corner followed by the Ferrari of Ed Hugus

in the main stands, seething and buzzing with the excitement of the moment and at the back of the grandstand a forest of periscopes stands up like Birnam Wood.

A mob of movement

Now at Indianapolis, with its terrifying massed flying start, or at a Grand Prix with howling engines, smoke and fumes, the start is a great moment. Here it is altogether different but none the less dramatic. The flag falls, and all you hear is the patter of running feet; then doors slam, an engine coughs into a great roar, then another and another until the air is filled with noise and the road with snarling cars piling out into a great mob of movement. Then they are all gone and there are a few moments of silence; all eyes turn down the road, and in an incredibly short time, about 3½ minutes, a low saloon comes tearing by, then a couple and then the whole pack; some voices shout "Gram Eel," but the novice is too confused by the noise and the speed and the whole spectacle to see the wood for the trees or identify colours and numbers, and it takes some laps before you can even tell a Ford from a Ferrari.

Incredibly fast

The cars at Le Mans these days are very far removed from yours and mine, very low built with huge engines behind the driver, nominally two-seaters and usually saloons, or at least roofed over. They are incredibly fast, faster than the Formula I Grand Prix cars. They would pass the grandstand at 170–180 mph and on the long Mulsanne straight they would get up to 210–215 mph. This sort of pace hour after hour after hour, with the night to encompass as well, is an appallingly gruelling ordeal for two men and their machine.

These arduous conditions have produced heroic performances, and it is good to know that from the very beginning of the race until today Britain has produced more winners than any other nation except Italy, who lead us 13 to 12. First came the Bentley era in the 1920s and 1930s; then, when the race was

Below . . . "The crowds forsake the stands for the hot-dog stalls or bars" . . .

Right: Hectic activity at the Ferrari pits

Right, below: The triumphant Fords take the chequered flag

All photographs of this year's race by courtesy of "Motor." Drawings by Michael Turner

started again after the war, a rich Jaguar harvest was reaped with an Aston Martin win as well. After this Ferrari won six times running and nine times in all until at last, in 1966 and at the third attempt, Ford with a massive entry of huge-engined cars, battered the Ferraris flat into the ground.

Some of the early races were monstrously exciting. In 1926 the last surviving Bentley crashed in the final half-hour and lost the race. Next year the whole British team when well ahead crashed in one great pile-up into a stalled car at White House corner, from which after a deadly terrifying silence pregnant with disaster one halting, badly-damaged Bentley limped back into the race from the ruins and then with ever-increasing spirit and persistence beat out the Aries cars and finally won.

Another Bentley moment was in 1928, when Jean Chassagne, the great French professional, hearing from his exhausted co-driver who had run all the way back to the pits that his Bentley was grassed a mile or more up the road with a tyre gone, grunted "Maintenant c'est à moi," and putting a big jack under each arm ran off down the road to the car and heaved and struggled to change the wheel and get it back into the race, not forgetting to bring in the torn remains of the old tyre, which the regulations required. All this is wonderfully told, in the best book yet written on motor racing, by S. C. H. Davis, who brought the ruined Bentley home in 1927 and whose son was in the Ford team in 1966.

Perhaps with modern motoring these great heroic days are past, and with the race average rising to 125 mph there is not much scope for running, digging, or even major mechanical replacements. But the race remains as gruelling a test as you can imagine – the drivers take spell-on-spell-off roughly two hours at a time, but the two hours' rest is pretty thin and must seem to end appallingly quickly. You can imagine it this way: with a small private plane you could fly from southern England in mid-morning, see the start and the race for some hours, dine at the Café de l'Hippodrome on the edge of the circuit, watch a little of the dramatic night racing and fly home to sleep in your own bed; next day you could fly over again in time for lunch, and find many of the same cars and drivers still at it, see the finish, and fly back and be home for dinner.

Yes, the night hours have a special flavour of their own; the cars roar by with brilliant headlights blazing and all sorts of coloured marker lights to identify them to their pits; the German two-litre Porsche cars which did so brilliantly in 1966 under the handicap of their limited size were especially conspicuous. But with the dark blotting out the surroundings the cars appear to be going faster than ever. The crowds forsake the stands for the hot-dog stalls or bars, or go to their tents or back into town; but on and on goes the race, on and on until the chilly dawn pales the lights and the new morning comes up.

Around noon on the Sunday, with four hours left to go, the scene begins to be less grim – for all that is except the tired drivers and their cars – the race has taken on a pattern which looks like persisting. Well-rested shaven men come out from their hotels in town, the frowsy car-sleepers spruce up a bit, drinks circulate, lunch is taken, the pits are rather relaxed – in the Porsche pit below us, where German discipline might be looked for, a baby-in-arms attends one pit stop and a dog-in-arms another and no one seems to mind.

And so we come to the climax. The marshal gets out the big chequered flag, the three great Fords in the race, two of them on the same lap, close up into formation and with headlights blazing roar over the finishing line in an attempted dead-heat and the chequered flag goes down. Le Mans 1966 is over.

Almost in the shadow of Ben Nevis a new mountain rises: a mountain of wood chippings from the plant which prepares logs for pulping at the new factory near Fort William of Scottish Pulp and Paper Mills, a subsidiary of the Wiggins Teape Group. By making its own pulp, mostly from home-grown timber, the factory saves some £8 million a year in foreign exchange that would otherwise be spent in importing wood-pulp. In the integrated process of pulp and paper making, the mills use chlorine and caustic soda supplied by Mond Division.
Photograph: Charles Scott (Mond Division)